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LOWER MANHATTAN INDOOR DUST TEST AND CLEAN PROGRAM PLAN

Background: This Test and Clean Program plan is the result of ongoing efforts to respond to concerns of residents and workers impacted by the collapse of the World Trade Center (WTC) towers. In March 2004, EPA convened an expert technical review panel to provide individual guidance and assistance to the Agency in its use of available exposure and health surveillance databases and registries to characterize any remaining exposures and risks, identify unmet public health needs, and individually recommend steps to further minimize the risks associated with the aftermath of the WTC attack.

The WTC Expert Technical Review Panel (WTC Panel) members met periodically in open meetings to interact with EPA and the public about plans to monitor for the presence of WTC dust in indoor environments and to individually suggest additional measures that could be undertaken by EPA and others to evaluate the dispersion of the plume and the geographic extent of environmental impact from the collapse of the WTC towers.

The WTC Panel members were charged, in part, with reviewing data from post-cleaning verification sampling to be done by EPA in the residential areas included in EPA Region 2's 2002-2003 Indoor Air Residential Assistance Program to verify that recontamination has not occurred from central heating and air conditioning systems. With the assistance of Westat, a contractor in the field of statistics, EPA developed a sampling plan to evaluate whether apartments previously cleaned in the Assistance Program had become recontaminated. The plan proposed by EPA was debated by the individual panel members, and most panel members thought that an alternate study to test for “contamination” rather than "recontamination" should be conducted.

The WTC Panel members also were charged with assessing the use of asbestos as a surrogate in determining risk for other contaminants. Using a peer review contract, EPA solicited comment from other external experts on this issue, and these experts provided a report that was shared with the WTC Panel members. These external experts generally supported the use of asbestos as a surrogate, but they encouraged the concurrent testing for lead. Some individual members of the WTC Panel, however, did not believe that asbestos was an appropriate surrogate in determining risk for other contaminants.

Other areas not specified in the WTC Panel members’ charge were also addressed by individual panel members as part of the discussions relating to assessing WTC-related contamination. These discussions led EPA to the concept that a WTC signature exists in dust. Sampling to determine the presence of the WTC signature, as well as the levels of contaminants of potential concern (COPC), would serve as the basis for determining the extent of WTC collapse contamination in indoor environments. The premise was that a signature could be developed for both the dust generated by the collapse and particulate matter generated by the fires which burned into December of 2001. Early sampling results led to the abandonment of a signature for the fire plume. A Final Report on the World Trade Center Dust Screening Method Study, which summarized efforts to investigate the validity of the collapse plume signature concept, was prepared by EPA and submitted for peer review. The peer review concluded that, "EPA has not made the case that its proposed analytical method can reliably discriminate background dust from dust contaminated with WTC residue," and that "[t]he proposed method has not demonstrated the utility of slag wool as a successful signature constituent." In consideration of these comments EPA announced in November 2005 its plan to move forward with a sampling plan that did not depend on a signature. At a final panel meeting on December 13, 2005, many panel members expressed their belief that EPA should continue efforts to investigate the validity of a collapse plume signature. Tim Oppelt, interim chairman of the WTC Panel at that time, would further discuss the peer reviewers' comments on the WTC dust signature with EPA.

Subsequent to the December 13, 2005 meeting, EPA further evaluated both the peer review and panel comments. EPA also conducted additional work to assist in answering questions that arose while considering the comments and discussed this work with panel members Paul Lioy, Morton Lippmann, and Gregory Meeker. A response to the peer review comments, summaries of the additional work performed by EPA, and an expanded statistical analysis of the study's data have since been completed. The overall variability observed in the inter-lab data and the demonstrated possibility of observing high levels of slag wool at sites not affected by the WTC collapse raise significant questions concerning the ability to use slag wool measurements generated with the current method as a tool for screening a sampled location for the presence of WTC related contamination. EPA's decision to proceed without a signature is unchanged as a result of these efforts; however, several modifications to the November plan have been made. These changes are described and incorporated into the text below.

In the June 2005 Draft Final Sampling Plan, EPA described an approach, based on the existence of a WTC signature, to be used to evaluate the presence and levels of COPCs within buildings in lower Manhattan and a portion of Brooklyn, including contaminants that could be markers for WTC building collapse dust. The Draft Final Sampling Plan reflected appropriate elements from the comments received from the public and the individual members of the panel as well as subsequent discussion and review by EPA staff. A primary objective of the study was to determine the geographic extent to which WTC building collapse dust remains detectable in indoor environments. The Draft Final Sampling Plan included sampling beyond Canal Street to as far north as Houston Street in lower Manhattan as well as a portion of Brooklyn. The Draft Final Sampling Plan had the following objectives:

(1) To estimate the geographic extent of WTC COPC resulting from the building collapse plume by sampling residential and non-residential buildings in lower Manhattan, and a portion of Brooklyn that agree to participate, and to provide a cleanup when appropriate;

(2) To relate results of the sampling to building cleaning history, construction, and to the role of central heating, ventilation, and air conditioning (HVAC) if the information collected will support such an analysis;

(3) To provide the data necessary to determine if a Phase II sampling should proceed, which will test for the presence of collapse residues in areas beyond the boundaries of the areas

currently tested, and to provide the data necessary to determine whether and what further actions are warranted; and

(4) To validate a screening method to identify WTC dust.

The absence of a WTC signature makes it infeasible to determine the geographic extent to which WTC dust continues to impact indoor environments and whether any exceedances of COPC are related to the WTC collapse. Several members of the panel have expressed the opinion that the peer review comments could be addressed and that EPA should perform additional sampling in the affected areas to validate a signature. EPA has considered whether the proposed sampling plan or a modification of the proposed sampling plan should be implemented.

EPA has concluded that in the absence of a unique marker for WTC dust, we would be unable to detect a remaining pattern of contamination due to the collapse of the WTC. The widespread cleaning of indoor environments, many known to have been impacted by WTC dust, and the sources of contamination in the urban environment further confound any attempt to attribute contamination to the WTC collapse. Appendix 1 explains additional considerations that led EPA to this conclusion. The Test and Clean Program to be offered in the absence of a signature is described below.

I. Geographic Extent and Eligibility

In the absence of a measure that can identify WTC dust, EPA will offer a voluntary Test and Clean Program targeted at the area below Canal Street and west of Allen and Pike Streets that was targeted in EPA Region 2's 2002-2003 Indoor Air Residential Assistance Program (Figure 1). The targeted area entirely contains the area where visible contamination with WTC dust was confirmed by EPA's Environmental Photographic Interpretation Center (EPIC) (Figure 2). Services will be offered as described below. There will be a period of two months during which residents and building owners in this area may request to participate in this program. Employees and employers will not be eligible for this program.

<u>Individual Residents</u>: Individuals who own or rent their apartment who are concerned that dust from the collapse of the WTC may still be present in their residence may request assistance from EPA.

<u>Buildings</u>: Owners, boards of cooperatives or condominiums and managers of residential or commercial buildings can request to have their building's common areas and HVAC system evaluated and cleaned, as necessary. After receiving the request, and upon signature of appropriate access agreements, common areas and/or other areas to which building management can provide access will be sampled as described below.

<u>Employees and Employers</u>: The Occupational Safety and Health Act of 1970 gives employees the right to file complaints about workplace safety and health hazards. If employees or their representatives believe that their working conditions are unsafe or unhealthful as a result of contamination by WTC dust they may follow the procedures outlined at http://www.osha.gov/as/opa/worker/complain.html to file a complaint. Alternatively,

employees, authorized representatives of employees, or employers can request an evaluation by the National Institute of Occupational Safety and Health of possible health hazards associated with a job or workplace. The procedure to be followed is outlined at http://www.cdc.gov/niosh/hhe/Request.html.

EPA will implement this effort by utilizing the $7 million in FEMA funding that has been earmarked for this program. In order to ensure that these funds are expended in a manner that will maximize the reduction in potential exposure to remaining dust, 1) EPA will not test spaces that were not cleaned after the collapse of the WTC, are currently uninhabited, and slated for demolition; and 2) EPA will not test in buildings constructed or reconstructed after May 2002 (when the cleanup effort at the WTC site was completed). EPA will accept requests from building owners and individual residences previously sampled by EPA. Requests within the area of confirmed contamination and in closest proximity to the WTC will be given priority for testing.

In general, a cleanup will be offered if a benchmark for any of the COPC is exceeded in any unit or building common area tested. EPA will conduct surveys to determine if the exceedance may be attributed to sources within or adjacent to the place of business or residence. If it is attributable, this information will be considered in conjunction with information on building cleaning history to determine whether clearance sampling or further cleaning will be offered. Further details on the testing procedures, development of benchmarks, and other design issues are provided below.

II. Approach to Characterization

All buildings and units tested will have a number of characteristics recorded to allow examination of potential relationships between results and the characteristics of the units and common areas sampled. Building and unit characteristics that may be relevant are described below. This section provides an overview of the strategy to characterize units, the common areas within buildings, and HVACs within buildings, if present. The Quality Assurance Project Plan (QAPP) describes in detail the protocol for how to determine where and how much to sample within common areas and units.

A “unit” generally denotes a reasonably well defined section of a floor that will be different for each building and building type. For example, a unit within a residential building could be an apartment.

Two sets of dust samples will be taken within each unit: (1) three or more samples at locations where dust-related exposures are likely to occur, such as in elevated horizontal surfaces (e.g., desk or table tops) and floors; and (2) three or more samples at locations where WTC dust may have accumulated but would not have frequently been cleaned, such as on top of cabinets. The first set of samples will be termed “accessible” samples, and the second set are “infrequently accessed” samples. Samples from these two types of locations will be taken by wipes and microvacs. These samples will yield results in load (weight or fibers per unit area) and will be compared with benchmarks.

EPA previously proposed to collect samples from a third set of locations (“inaccessible” areas). These samples were to be bulk dust samples or collected by HEPA vacuums and would yield results in concentration (weight or fibers of contaminant per weight of sample). The location of many of the inaccessible areas makes it impractical to obtain load samples (mass per unit area) that could be related to the benchmarks. Concentration (weight per weight) of a contaminant in settled dust is a poor indicator of risk. A very dusty environment may pose a risk even if the concentration in dust is low. Conversely, an environment with little dust would not pose a risk even if there was a high concentration of the contaminant in the small amount of dust. The “inaccessible” area sample results were only to be used to screen for potential COPC in dust and would not trigger a cleaning. These samples were not to be used for cleaning decisions and the sampling plan no longer has as an objective determination of the geographic extent of indoor contamination from WTC COPC. Therefore, in order to be able to devote the maximum extent of resources to testing requests, we will not sample “inaccessible” locations.

Wipe samples will be analyzed for the COPC lead and polycyclic aromatic hydrocarbons (PAHs), and microvac samples will be analyzed for the COPC asbestos and man-made vitreous fibers (MMVF). Wipe and microvac samples will be taken in proximate locations so that for each location sampled within a unit, there will be measurements of the four COPC. Indoor air samples will also be collected in units and common areas at locations proximate to the locations where accessible dust samples are collected. Indoor air samples will be analyzed for asbestos and MMVF. Further detail on the selection of locations to be sampled within common areas and units will be provided in the QAPP.

The analytical results from both the air samples and the dust samples will be used to determine whether or not a cleaning will be offered to the occupant or owner of the unit being tested. Details on the criteria used to make these decisions are described below.

Specific building and space characteristics will be gathered in order to aid in understanding the results. The information will be gathered by using preprinted checklists that will record:

<u>Descriptive information</u>

Building age and type
Location of floors sampled per building
Number of rooms sampled per floor
Square footage of floors and of space sampled per floor
Location of space sampled on floor
Cleaning and renovation history since WTC collapse
Type, number and age of windows in spaces sampled
Number of window or wall HVAC units
Cleaning and replacement history of window or wall HVAC units since WTC collapse
Visible WTC dust reported present in unit
Reported cleaning frequency and date of last cleaning prior to sampling
Carpet present
Carpet cleaned or replaced since WTC collapse

<u>Attribution Information</u>

Location and amount of friable asbestos material present in sampled space
Location and area of MMVF present, i.e., ceiling tiles, pipe insulation, spray on fireproofing
Location and amount of chalking/peeling paint present
Current use of space
Significant particulate or combustion sources within sampling area, e.g., fireplace, stove, occupant who smokes
Significant particulate or combustion sources within or adjacent to the building, e.g., above fast food restaurant, adjacent to emergency diesel generator exhaust

Source attribution will be a critical factor in determining whether to retest after cleaning. For example, if lead exceedances trigger a cleanup, a source survey will be conducted where exceedances are found. If it is found that the exceedance is due to a source within the building or adjacent to the building, no further cleaning or re-sampling to demonstrate clearance will be offered. Although most pertinent to lead contamination, the same principle applies to the other COPC: if the exceedances resulting in the need to cleanup can be attributed to a source within or adjacent to the building, no further cleaning or re-sampling to demonstrate clearance will be offered.

<u>Central HVAC Design Information</u>

Location of air inlets
Location of filters or other air cleaning devices in system
Number and location of HVAC return ducts in sampled space
Central HVAC cleaning and replacement history since WTC collapse

III. Contaminants of Potential Concern (COPC)

The COPC that will be measured in this program are asbestos, MMVF, PAHs and lead. A total of six COPC, including these four as well as silica and dioxin, were identified by EPA Region 2 during 2002. A full discussion of these six COPC can be found in *World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks* (COPC Report, US EPA, 2003a). The COPC Report includes justifications for selecting these WTC-related contaminants as COPC as well as the health-based benchmarks for these contaminants in indoor air and settled dust. The COPC Report and the COPC benchmarks developed in it were adopted by EPA after peer review.

EPA's preferred approach to establishing cleanup benchmarks is risk-based. Risk-based benchmarks for lead and PAHs in settled dust were developed in the COPC Report because the primary route of exposure for these two contaminants in an indoor environment is incidental ingestion associated with direct contact to settled dust. PAHs and lead are both toxic via ingestion. Asbestos and MMVF toxicity occurs primarily from inhalation exposure. Accordingly, the risk from asbestos and MMVF exposure would be assessed by determining fiber concentrations in air. Risk-based benchmarks for asbestos and MMVF in indoor air also were developed in the COPC Report and will be employed in this program. Concern was raised by members of the public and the panel that reservoirs of asbestos and MMVF may be present that might not be readily re-entrained during air sampling. Consequently, sampling for asbestos and MMVF in settled dust will also be performed in this program. The benchmarks developed to trigger cleanup for asbestos and MMVF in settled dust are not risk-based. Rather, they are intended to identify a significant fiber load in settled dust based on multiple lines of evidence including an experience standard developed by experts in the field of asbestos sampling, comparison with background, and consideration of and consistency with the trigger level employed in the cleanup of asbestos contaminated residences in Libby, Montana. These benchmarks are not risk-based; since they are in part based on site specific background, they are not intended for use elsewhere.

EPA will use pre-existing, risk-based dust benchmarks for two of the COPC: PAHs and lead. These benchmark values, at 150 $\mu g/m^2$ for PAHs and 40 $\mu g/ft^2$ for lead, will be used in post-sampling decision making with regard to cleanup activities (see section below on Decision Criteria). The PAHs dust benchmark is risk-based. It was developed as part of the earlier COPC effort, and its value was supported in the peer review. The lead dust benchmark was developed by the United States Department of Housing and Urban Development (HUD US HUD, as amended 2004). Risk-based benchmark values for asbestos and MMVF were established for sampling in air, but not for dust, in the COPC Report. Although risk-based benchmarks were also developed for PAHs and lead in air, the primary route of exposure to these compounds in dust is through incidental ingestion. Consequently, sampling for PAHs and lead in indoor air will not be conducted.

The risk-based benchmark for lead in settled dust in the COPC Report was based on the HUD screening level (25 $\mu g/ft^2$) for accessible floor space. The HUD screening level was consistent with the purpose of the wipe sampling performed in EPA's 2002-2003 WTC Indoor Air Residential Assistance Program (i.e., to determine the efficiency of the cleaning techniques rather than as an action level for triggering a cleanup). EPA did not use the HUD screening level to trigger a cleanup. The benchmarks developed for the current WTC sampling program will serve as action levels for cleanup. As such, the risk-based benchmark for lead should be consistent with the dust hazard/clearance standards in the HUD regulation. Therefore, the following criteria established by HUD will be followed:

Floors = 40 $\mu g/ft^2$
Window sills = 250 $\mu g/ft^2$
Window troughs = 400 $\mu g/ft^2$

In earlier versions of this sampling plan, the capacity of asbestos and glass fibers to re-entrain in indoor air, and the possibility of developing settled dust benchmarks based on an inhalation pathway were discussed. However, development of a "k" factor, which is an empirical factor relating a dust concentration to an air concentration, was not pursued for this sampling plan in accordance with recommendations of individual members of the panel, who cited the considerable uncertainty inherent in characterizing the relationship between fiber loads in indoor air and settled dust. Factors contributing to this uncertainty include surface porosity, activity patterns, fiber dimensions, room volume and air exchange rates. The peer reviewers of the COPC Report were also of this opinion.

Given the uncertainty associated with the modeling of air concentrations based on asbestos loads in settled dust, a weight-of-evidence approach has been developed for establishing a benchmark for asbestos in settled dust. Experts in indoor asbestos sampling have published guidelines for interpreting the results from sampling of asbestos in indoor settled dust (Millette & Hays, 1994, p25). The recommended method for sampling is by microvac (ASTM 5755). Millete and Hays provide the following interpretation for asbestos loads in settled dust:

1,000 S/cm^2 = "Low" concentration
10,000 S/cm^2 = "Above Background" concentration
100,000 S/cm^2 = "High" (i.e. significant release) concentration

[Note: This document references two types of fibrous materials: asbestos and man-made vitreous fibers (MMVF). These materials have alternately been described as fibers or structures in various citations in the literature. For the purposes herein, the term "structures" refers specifically to asbestos as analyzed by transmission electron microscopy (TEM), and is consistent with the counting procedures detailed in the Asbestos Hazard Emergency Response Act. MMVF and asbestos analysis by phase contrast microscopy (PCM) are referred to as "fibers."]

The asbestos contamination in the town of Libby, Montana, offers additional information for consideration in the development of a benchmark for asbestos in settled dust. At the Libby site an action level of 5,000 S/cm^2 in generally accessible areas has been established for triggering a cleanup in a residential dwelling. Air sampling is performed after the cleanup to verify the effectiveness of the cleaning.

Finally, there has been discussion at the panel meetings relating to the use of a multiple of the background level for setting a benchmark for asbestos in settled dust. A factor of 3X had been proposed in the October 2004 Draft Sampling Plan. EPA's WTC Background Study (US EPA, 2003b) reported a mean value of approximately 2,250 S/cm^2 for residential dwellings sampled by the microvac method.

Based on the considerations above, a benchmark of 5,000 S/cm^2 will be applied for asbestos in settled dust. This value is the approximate midpoint referenced by Millete and Hays for "Low" and "Above Background" concentrations. It is consistent with the action level used for residential cleanups in Libby, Montana, and it represents a value that is approximately two to three times the background level as characterized in EPA's WTC Background Study. A benchmark for asbestos in air was established in the COPC Report.

A benchmark for MMVF in settled dust was developed with consideration given to both its toxicity and background levels relative to asbestos. In one respect, it would be intuitive to establish a value that is less stringent than the number (5,000 S/cm^2) developed for asbestos. This is based on the understanding that, on a fiber-for-fiber basis, asbestos is viewed as more hazardous than fibrous glass (a prototypical form of MMVF). This is reflected in the OSHA Permissible Exposure Limit (PEL) for fibrous glass which is an order of magnitude more stringent for asbestos (0.1 f/cc vs. 1.0 f/cc - PCM) and the greater than an order of magnitude difference in the COPC Report's WTC risk-based benchmarks established for asbestos (0.0009 S/cc – PCM equivalents) and fibrous glass (0.01 f/cc). Conversely, the background levels of MMVF found in EPA's WTC Background Study are more than an order of magnitude lower than the levels reported for asbestos. However, there were fewer MMVF samples (compared with asbestos) obtained in the WTC Background Study, lending greater uncertainty to the reported value. Also, unlike asbestos, there is little in the scientific literature relating to MMVF loads (fibers per unit area) in settled dust. On the basis of these factors, a case could be made for setting the MMVF benchmark in settled dust either considerably higher (based on toxicity) or lower (based on background level) than the value established for asbestos. The value applied to asbestos, 5000 S/cm^2, will also be applied to MMVF. This value was specifically developed for this program, is not risk-based and is not intended for use in any other context. Risk-based benchmarks of 0.01 f/cc for MMVF in air, and 0.0009 S/cc for asbestos in air were established in the COPC Report.

Silica and dioxin, selected as COPC in 2002, are not included in this program. The COPC Report based the inclusion of dioxin as a COPC on the levels found in the ambient air in the weeks/months after September 11, 2001, when combustion processes were still taking place. At the time the COPC Report was finalized, limited preliminary data on dioxin wipe samples (approximately 200) in lower Manhattan residential dwellings were available. These data indicated a preponderance of non-detects. However, the presence of dioxin at elevated concentrations in the ambient environment post 9/11 was a sufficient basis for including dioxin as a COPC. Dioxin concentration in ambient air returned to background levels by early December of 2001. In addition, the complete data set of over 1,500 dioxin wipe samples obtained from residential dwellings in lower Manhattan revealed only eight exceedances of the risk-based benchmark of 2 ng TEQ/m^2 (TEQ is an acronym for Toxic Equivalents which is a cumulative measure of toxicity for a suite of dioxin and furan compounds that are dioxin-like). Given this evidence, additional sampling for dioxin is not included in this program.

Crystalline silica was included as a COPC based primarily on the basis of its relative abundance in bulk and settled dust samples taken in both outdoor and indoor locations during the fall of 2001. At that time, the amount of residual dust/debris in lower Manhattan was significant. The concern with the presence of crystalline silica in dust/debris relates to its ability to become airborne and ultimately inhaled. Sampling conducted by the Agency for Toxic Substances and Disease Registry (ATSDR) and the New York City Department of Health and Mental Hygiene (NYCDOHMH) in the fall of 2001 (ATSDR/NYCDOHMH, 2002) demonstrated measurable levels of crystalline silica in indoor air when high concentrations of crystalline silica were observed in settled dust (up to 31% by weight). However, the ATSDR/NYCDOHMH report concluded, "*Short-term exposure to quartz (crystalline silica) even for a continuous year of exposure at the highest estimated air concentration, is not expected to result in any adverse health effects. Assuming worst-case theoretical assumptions, the estimated quartz (crystalline silica) levels measured cannot rule out adverse health effects from chronic exposures (i.e., 30 years). For individuals who conduct frequent cleaning of their residences, as recommended in this report, or participate in the U.S. Environmental Protection Agency cleaning/sampling program, it is unlikely that their exposure would resemble these worst-case conditions.*"

The significant reduction in residual dust/debris (and therefore crystalline silica) in both the outdoor (e.g., cleanup of Ground Zero) and indoor (e.g., EPA's 2002 WTC Indoor Air Residential Assistance Program) environment over the past three-plus years would further reduce the potential for this mineral to pose a potential chronic health threat. Additionally, sampling for relatively low levels of crystalline silica is complicated by the fact that this mineral is a major component of the earth's crust (Toxicology, Casarett & Doull, 1996). The following statement, from the COPC Report relates this fact to the urban environment: *"Since quartz (crystalline silica) is a common material in sand, finding this mineral in a city where there is a great deal of concrete is not unusual."* Consequently, sampling for crystalline silica in settled dust is not included in this program.

Mercury has been the subject of much debate in relation to its exposure potential post 9/11. Previously, there have been reports of elevated mercury levels in both biological and environmental samples. In the first case, medical monitoring of Port Authority officers assigned to the WTC site registered marginally elevated mercury blood levels in four officers. An investigation (NYC Department of Design and Construction, 2002) revealed no elevation in urine mercury levels in this group, nor could an environmental source be identified. It was determined that the officers were not dietary restricted for known sources of mercury (e.g., fish) prior to screening. Repeat sampling under controlled dietary conditions demonstrated blood mercury levels to be within normal limits. Additional evidence of negligible occupational exposure to mercury vapor during the WTC rescue /recovery operation is provided by a study in firefighters. Edelman et al. (2003) reported that "three exposed firefighters had total blood ercury levels > 20 µg/L, a conservative upper reference limit. Because blood inorganic mercury was < 1.7 µg/L for all exposed firefighters, these elevated total blood mercury concentrations represent organic mercury contributions from dietary sources (e.g., fish consumption) rather than from exposure at WTC".

Although a post 9/11 environmental investigation by I.H. Consultants Inc. (Singh, 2002) in various indoor and outdoor locations in lower Manhattan did identify mercury vapor levels that were reported to be orders of magnitude above urban background concentrations, the sampling was performed with a Jerome Meter which is a particularly poor instrument for measuring low-level airborne mercury. The mercury concentration in ambient air in urban environments is generally below 20 ng/m^3 (Johnson, 2002). The detection limit for the Jerome Meter is 3,000 ng/m^3. Many of the elevated levels, relative to background, detected in the I.H. Consultants report were at or close to the detection limit of the Jerome Meter. A subsequent investigation by Johnson (2002) in the same locations sampled by I.H. Consultants was performed using a Lumex RA-915 mercury vapor analyzer. The detection limit for this instrument is 2 ng/m^3 (1,500X more sensitive than the Jerome Meter). None of the elevated readings reported by I.H. Consultants could be replicated with the Lumex. In over 100 individual samples, the highest concentration detected was 319 ng/m^3, a reading that is an order of magnitude below the detection limit of the Jerome Meter. EPA's chronic reference concentration (RfC) for mercury vapor is 300 ng/m^3. Evaluation of these data along with additional data sources detailed in the COPC Report, including preliminary mercury wipe sampling results from EPA's 2002 WTC Indoor Residential Assistance Program, formed the basis for not including mercury as a WTC COPC. At the present time, the complete wipe sampling data set is available, and it contains over 1500 samples. Results show that there were only six exceedances of the benchmark of 157 μg/m^2 and the highest single value was 248 μg/m^2.

RJ Lee Group Inc. (2003, 2004) performed extensive environmental sampling in the former Deutsche Bank building at 130 Liberty Street. This building, now slated for deconstruction, was heavily impacted by the WTC disaster. Mercury was sampled in settled dust by wipes and in indoor air by a Lumex direct reading mercury vapor analyzer. Over 2,000 wipe samples were obtained. The maximum recorded value (600 μg/m^2) exceeded EPA's risk-based benchmark for mercury (157 μg/m^2) by approximately a factor of four. However, the average mercury wipe sample was less than 20 ug/m^2, well below the risk-based benchmark. RJ Lee Group Inc. computed 95% upper confidence limits (UCL) on the mercury wipe sampling on each of the building's 40 floors. A UCL is a measure of uncertainty in an estimated mean due to sampling, measurement, and other sources of variability in a set of data. The 95% UCL is commonly employed in EPA hazardous site assessments to provide a conservative upper bound estimate on the average site-wide contaminant level. None of the individual 95% UCLs by floor exceeded the risk-based benchmark, indicating that area-wide mercury did not pose a significant exposure threat from contact with residual dust. The air sampling performed by RJ Lee Group Inc. only recorded significantly elevated levels of mercury in air under circumstances unlikely to be encountered in an occupied space, such as torch cutting of steel. All ambient air samples obtained in general office space were below EPA's chronic RfC for mercury of 300 ng/m^3.

Results of ambient, outdoor, mercury vapor monitoring at 4 Albany Street adjacent to 130 Liberty Street have consistently demonstrated levels to be below EPA's RfC for mercury of 300 ng/m^3 (http://www.lowermanhattan.info/construction/rebuilding_spotlight/epa_air_monitoring_reports_87937.asp).

IV. Analytical Methods and Sampling Protocols

These are shown in Table 1. Lead will be sampled with wipes, as the risk-based benchmark for lead is based on a wipe sampling method (US EPA, 2003a). PAHs will also be sampled by wipes. The risk-based benchmark for PAHs was developed on the basis of exposure and health-impact considerations and was not specific to a sampling method (US EPA, 2003a). It is expected that wipe sampling will capture the PAHs that exist on dust particles and also PAHs that could be trapped on oily films that may be present on non-porous surfaces like table or countertops. As such, a wipe sampling approach for PAHs measurement is expected to provide a conservative (i.e., as high as possible) estimate of the PAHs available for exposure. The remaining COPC, asbestos and MMVF, will be sampled by using a microvac for dust, and sample cassettes for air. The decision to use a vacuum approach for these COPC in dust, in contrast to a wipe method, is due to the existence of an ASTM standard sampling method for asbestos in dust. The detailed protocols describing procedures to be used to identify locations within units to sample, procedures to sample using wipes, microvacs, air sampling cassettes and the analytical methods are all contained in the QAPP for this program.

V. HVAC Evaluation

EPA previously proposed to collect samples from a number of locations in HVAC systems. These samples were to be bulk dust samples or collected by HEPA vacuums and would yield results in concentration (weight or fibers of contaminant per weight of sample). The configuration of HVAC systems makes it impractical to obtain load samples (mass per unit area) that could be related to the benchmarks. Concentration (weight per weight) of a contaminant in settled dust is a poor indicator of risk. A very dusty environment may pose a risk even if the concentration in dust is low. Conversely, an environment with little dust would not pose a risk even if there was a high concentration of the contaminant in the small amount of dust. Therefore, the COPC sampling results for HVACs were not to be used to trigger a cleaning. These samples were not to be used in any objective manner for cleaning decisions. The decision for HVAC cleanup was proposed to be and remains based on the 95% UCL for a COPC in the common areas of the building. In order to be able to devote the maximum extent of resources to testing requests we will not sample within HVAC systems.

VI. Decision Criteria for Activities Following Sampling

The indoor sampling program outlined here will provide data that will form the basis for decision making on whether to offer a cleaning of the unit being sampled, common areas and the HVAC in the building being sampled, and whether to conduct any additional sampling within a unit or common areas of a building. This section only outlines the process for these decision endpoints**.**

Figure 3 displays a decision tree for the testing and cleaning evaluation. The theme inherent throughout this figure is that, where COPC exceed benchmarks, a cleanup will be offered to the owner or occupants of those units or buildings. For units, this translates to the following: if at least one COPC sample in a unit has an exceedance of a benchmark, then a cleanup is offered. The decision for HVAC cleanup is based on the 95% UCL for a COPC in the common areas of the building. Specific procedures for units, buildings and HVACs are described below. After a cleanup is accomplished, the standard procedure will be for EPA to retest to ensure that the cleanup has been effective. However, source attribution will be a critical factor in determining whether to retest after cleaning. For example, if lead exceedances trigger the 95% UCL criteria for a HVAC cleanup as described below, a cleanup will occur, as with other COPC triggering the 95% UCL. However, a source survey will be conducted where exceedances are found, if the exceedance is due to a source within the building or adjacent to the building, no further cleaning or re-sampling to demonstrate clearance will be offered. Although it is most pertinent to lead contamination, the same principle applies to the other COPC: if the exceedances resulting in the need to cleanup can be attributed to a source within or adjacent to the building, no further cleaning or re-sampling to demonstrate clearance will be offered.

Approach for Unit Areas: Typically, EPA makes decisions on cleanup by using risk-based benchmarks for concentrations of COPC. For fibrous materials, such as asbestos, the risk-based peer-reviewed benchmarks are based on indoor air concentrations. In this program, EPA will also be determining load of COPC by wiping or vacuuming surfaces for settled dust. This has been the preferred approach for many groups in the affected community and for many individual members of the panel. The COPC Report established risk-based benchmarks for asbestos and MMVF in indoor air but not in settled dust. The derivation of cleanup benchmarks for asbestos and MMVF in settled dust was described above in the COPC section. In the Test and Clean Program, we will conduct settled dust sampling in both accessible (for current hazard assessment) and infrequently accessed (for potential contaminant reservoirs) areas. A potential hazard can occur from contaminant reservoirs in infrequently accessed areas through contamination/recontamination of accessible areas and/or direct contact with these reservoirs. In either case, the contaminant load in these areas would need to be significantly greater than the aforementioned benchmarks to pose a hazard, since they are infrequently accessed. Accordingly, separate benchmarks in settled dust for infrequently accessed areas have been established. Source attribution will be a critical factor in determining whether to retest after cleaning. See discussion in the HVAC section for an example of how source attribution will be considered.

Accessible Areas: As described above, benchmarks for COPC in settled dust have been established. Because these benchmarks are based on either the potential for direct contact for ingestion toxicants (lead and PAHs) or re-entrainment potential for inhalation toxicants (asbestos and MMVF), their application is specific to contaminant loads in accessible areas that are routinely contacted (e.g., floors, countertops, etc.). The benchmarks for accessible areas are listed below:

		Dust	Air
Lead	-	40 µg/ft^2	Not applicable
PAHs	-	150 µg/m^2	Not applicable
Asbestos	-	5,000 S/cm^2	0.0009 S/cc
MMVF	-	5,000 f/cm^2	0.01 f/cc

[Note: As per the HUD criteria described above, a 250 µg/ft^2 benchmark for lead will be used to evaluate window sill samples.]

Infrequently Accessed Areas: The development of these benchmarks has taken into consideration recontamination potential and direct contact. In addition, relevant guidance/ regulations were reviewed to inform benchmark development. Because infrequently accessible areas (e.g., out of reach shelving, etc.) are likely to represent a considerably smaller surface area and direct contact threat relative to accessible areas, a higher-level benchmark is indicated. With respect to relevant guidance/regulations, HUD provides a model for setting a two-tiered benchmark. The friction associated with the movement of lead-painted windows creates reservoirs in the window troughs that can serve as a source of contamination to other areas as well as a significant, although infrequent, source of direct contact exposure. The HUD clearance standard for window troughs is 400 µg/ft^2, a factor of ten greater than the standard for floors (40 µg/ft^2). Therefore, the HUD clearance standard for window troughs will serve as the benchmark for evaluating wipe samples obtained from infrequently accessed areas that may serve as recontamination reservoirs and/or sources of heightened direct exposure. Like that for lead, the benchmark (accessible areas) for PAHs in settled dust is risk-based and driven by the potential for children to routinely contact accessible surfaces (e.g., floors, walls, tables, countertops, etc.). Similarly, a benchmark for infrequently accessed areas should reflect reduced direct exposure potential as well as a limited area source for potential recontamination of accessible areas. Therefore, the same order-of-magnitude factor in the HUD clearance standards for floors and window troughs will be applied to the PAHs settled dust benchmark for infrequently accessed areas.

Benchmarks for asbestos and MMVF in settled dust for accessible areas were based in part on the work of Millete and Hays (1994) for interpreting measurements of asbestos in settled dust obtained by microvac sampling. The benchmark for asbestos (5,000 S/cm^2) was the approximate midpoint between the values referenced as "low" (<1,000 S/cm^2; i.e., unlikely to result in a significant re-entrainment potential) and "above background" (> 10,000 S/cm^2). The work of Millete and Hays established a third value (>100,000 S/cm^2) equating to significant releases from source material. The benchmark for infrequently accessed areas for asbestos will be 50,000 S/cm^2. This is approximately the midpoint between the two reference values of 10,000 ("above background") and 100,000 ("significant releases") and is consistent with the 10:1 ratio used above for PAHs and lead for the difference between the accessible and infrequently accessed benchmarks.

The MMVF benchmark for settled dust in accessible areas was set at the same level as asbestos. This was justified on the basis of toxicity and concentration observations, as discussed above. A different approach was taken to assign a benchmark for MMVF for infrequently accessed areas; it is not based on the midrange between two reference values, but rather on actual WTC dust measurements of MMVF. Samples of WTC dust from both outside and inside locations taken near Ground Zero during September 2001 and also during 2004-2005 were measured for various types of MMVF, including slag wool, and they were found at high levels (Lowers, 2005; Meeker, 2005). Slag wool was the predominant MMVF, comprising about 80% of the total MMVF concentration. Slag wool concentrations (in fibers of slag wool per gram of dust, f/g) ranged from 113,000 to 13,400,000 f/g, with this high measurement from an outdoor sample taken by the United States Geological Survey (USGS) near Ground Zero on September 16, 2001. The next highest sample was 11,800,000 f/g, taken indoors at the Deutsche Bank building during the fall of 2004. The next highly concentrated WTC dust sample contained 5,700,000 f/g of slag wool, also taken at the Deutsche Bank building in the latter part of 2004. Although heterogeneity in the concentration of slag wool in WTC dust may account for this drop-off in fiber concentration, a likely contributing factor is dilution with non-WTC dust. The average of the two high values listed above, 12,600,000 f/g, is utilized to represent undiluted WTC dust. USGS reports a density of WTC bulk dust to be 0.339 g/cc. Thus, there are 4,271,400 f/cc of slag wool (12,600,000 f/g * 0.339 g/cc) in 100% WTC dust. Assigning a value of 1 millimeter as the thickness of a dust layer in an "infrequently accessed" area yields a fiber load of 427,140 f/cm^2 (4,271,400 f/cc * 0.1 cm). At a dilution of 10% WTC dust in the sample, the slag wool load would be 42,714 f/cm^2 (427,140 f/cm^2 * 0.10). Based on USGS estimates that slag wool comprises about 80% of total WTC MMVF, the corresponding benchmark for MMVF would be 53,392 f/cm^2. Rounding down to the nearest ten-thousand yields a benchmark of 50,000 f/cm^2.

With this approach, an MMVF benchmark for infrequently accessed areas is based on actual WTC dust MMVF concentrations, coupled with a conservative assumption that as little as a 10% dilution in these areas would be sufficient to meet the criteria.

In summary, the following are the benchmarks for infrequently accessed areas:

Lead	=	400 µg/ft^2
PAHs	=	1,500 µg/m^2
Asbestos	=	50,000 S/cm^2
MMVF	=	50,000 f/cm^2

Approach for Buildings: The decision criteria for cleanup of common areas in buildings parallel those for individual units. If at least one COPC sample in a common area has an exceedance of a benchmark, then a cleanup will be offered for the area. However, source attribution will be a critical factor in determining whether to retest after cleaning.

Approach for HVACs: The decision criteria for a HVAC cleanup use the 95% UCL on a mean contaminant level for accessible areas, infrequently accessed areas, or air samples in common areas. A UCL is a measure of uncertainty in an estimated mean due to sampling, measurement and other sources of variability in a set of data. The 95% UCL defines a value that will be exceeded by the true mean approximately 5% of the time in repeated sampling. The 95% UCL is commonly employed in EPA hazardous site assessments to provide a conservative upper bound estimate on the average site-wide contaminant level. The UCL will be used in the decision process as follows: If the 95% UCL for the estimated building mean in common areas exceeds the benchmark value for a COPC, then this may be considered to provide support for the decision to offer to clean the building HVAC system. Separate analysis will be conducted for air samples, and accessible and infrequently accessed areas, and each will be compared with its own benchmarks. An exceedance of the 95% UCL for any benchmark in air or in either set of accessible areas will be the basis for offering a HVAC cleanup.

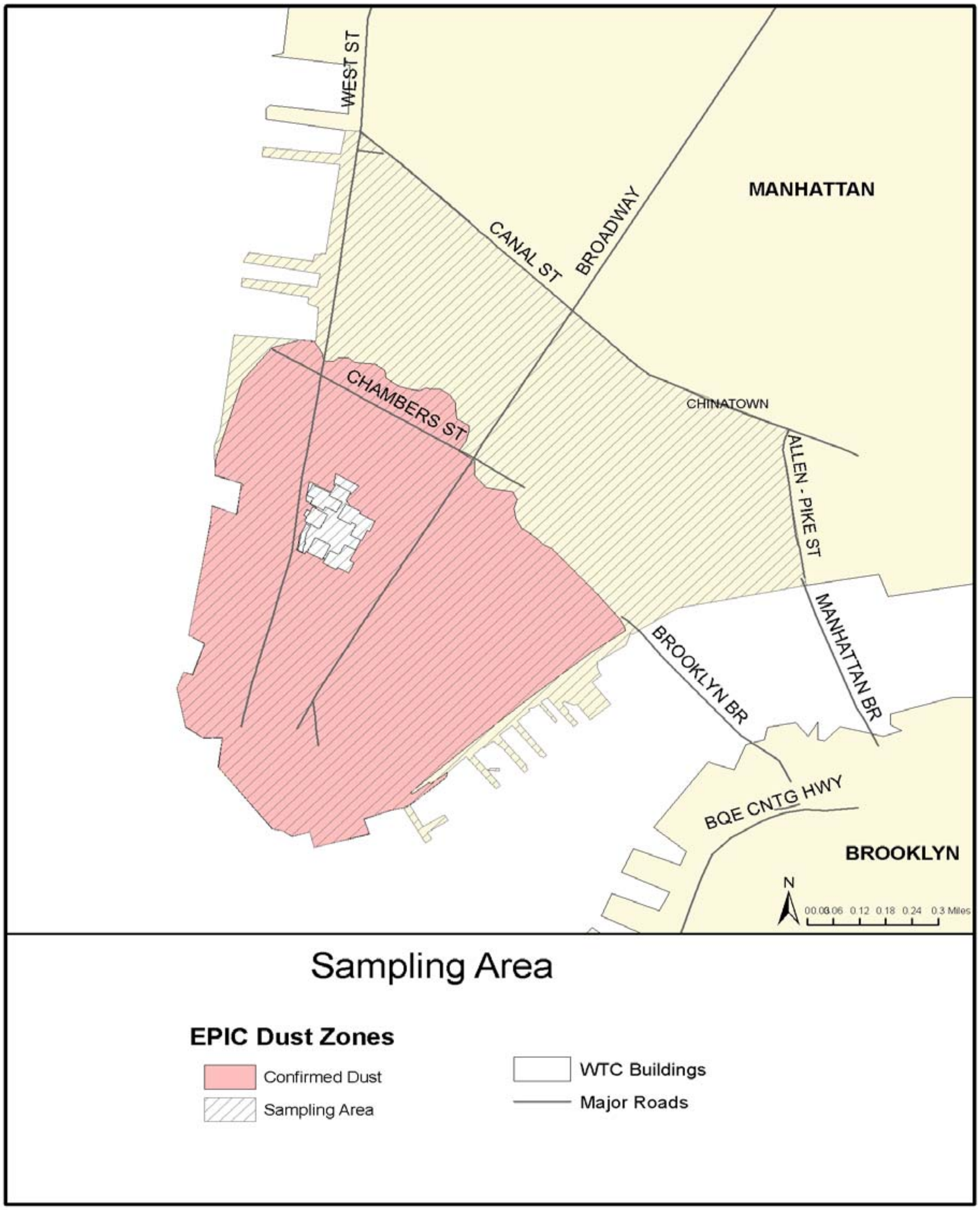


Figure 1. The area of lower Manhattan bounded by Canal, Pike, and Allen Streets that will be eligible for participation in the Test and Clean Program.

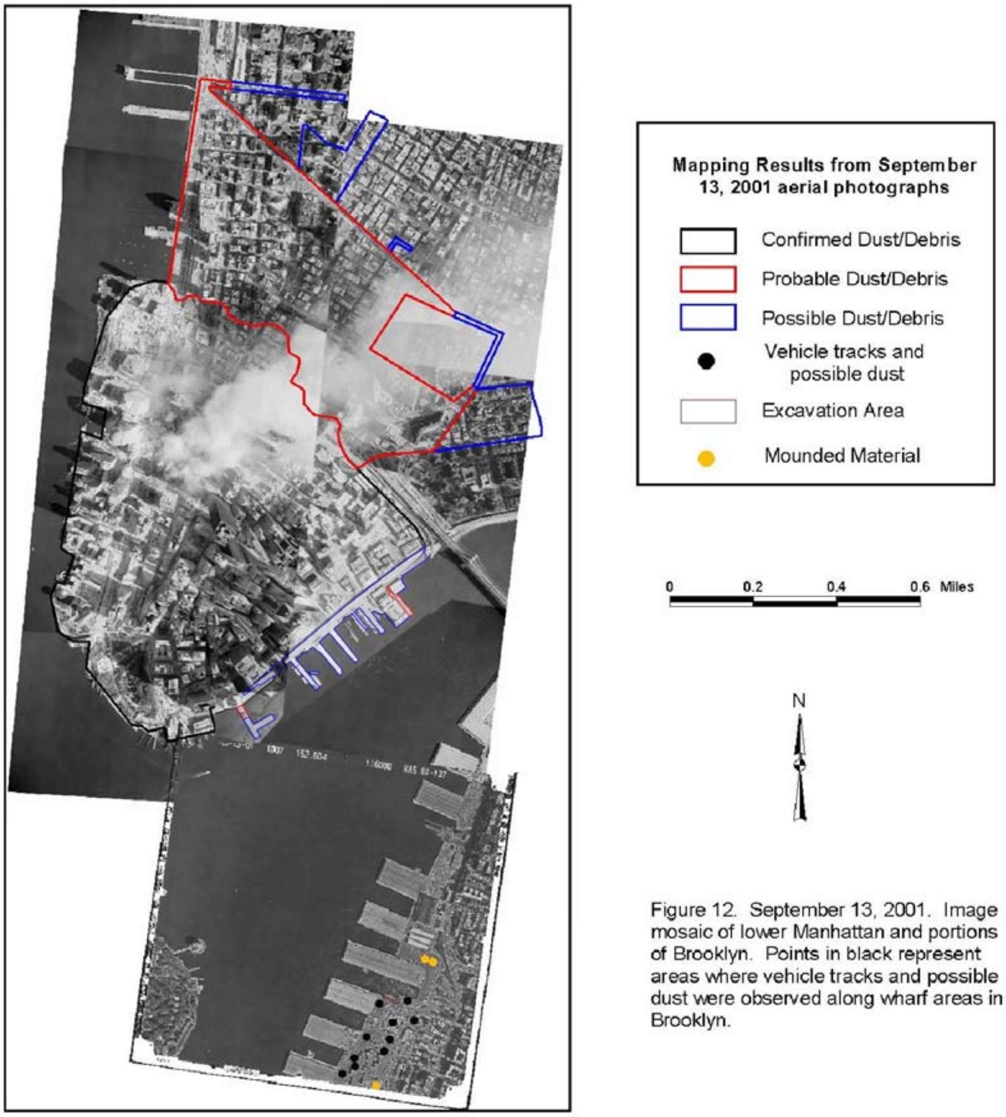
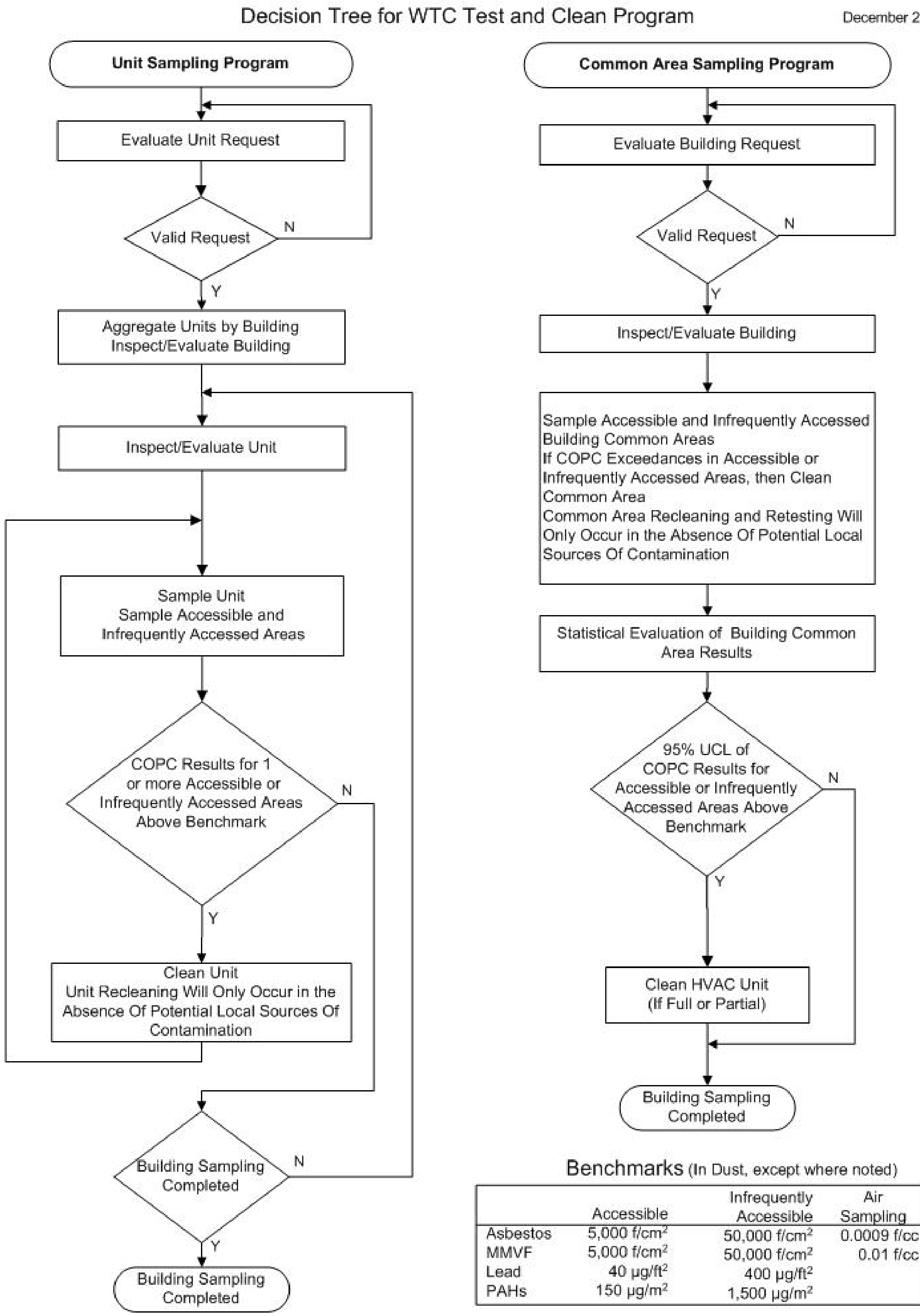


Figure 2. Display of analysis conducted by EPA's Environmental Photographic Interpretation Center (EPIC; December 2005).



	Accessible	Infrequently Accessible	Air Sampling
Asbestos	5,000 f/cm^2	50,000 f/cm^2	0.0009 f/cc
MMVF	5,000 f/cm^2	50,000 f/cm^2	0.01 f/cc
Lead	40 µg/ft^2	400 µg/ft^2	
PAHs	150 µg/m^2	1,500 µg/m^2	

Figure 3. Decision tree for WTC Test and Clean Program.

Table 1. Sampling and analytical methods for the Test and Clean Program.

Type of Location	Locations	Samples to be collected	Number of Locations
Accessible areas are areas in which exposures of residents or the general public readily occur.	i) Area or wall-to-wall carpeting. Locations include, in the order of most to least preferred location (on the basis of exposure considerations): 1) in the main entrance used for access and egress from the building; 2) carpet in the secondary, less heavily used entrance to the unit; 3) carpet in the center of the most frequently used play area for children under the age of six; and 4) carpet in an acknowledged or evident route of high traffic flow (i.e., stairs, hallway, etc.) ii) Kitchen tiled floor, hardwood floors, or hard floors of other surfaces types (laminate, e.g.) iii) Draperies/curtains in the living room, which is the primary location if unit is a residence, and then draperies/curtains in other rooms of the unit iv) The wall at hand level for a resident child or adult where there are no children v) The wall adjacent to the head of the bed in a child's bedroom, or in the adult bedroom where no children occupy the unit vi) Kitchen counter tops vii) Table or desk tops viii) Upholstered furniture	1 microvac, 1 PAHs wipe, 1 metal wipe at each location sampled	Scaled to floor area as follows: <1000sf = 3 locations, >1000 <5000sf = 5 locations, >5000sf = 7 locations, >10000sf = 10 locations
Infrequently accessed areas are areas in which dust may accumulate but cause infrequent exposure of residents or the	i) Trough of a window sill ii) Top of vent ducts, or hot water pipes iii) On top, beneath or behind large appliances or objects of furniture such as beds, chests, refrigerators, upright freezers, built	1 microvac, 1 PAHs wipe, 1 metal wipe at each location sampled	Scaled to floor area as follows: <1000sf = 3 locations, >1000 <5000sf = 5 locations, >5000sf = 7 locations, >10000sf = 10 locations

general public	in file cabinets or bookcases		
Indoor Air Sampling	Indoor air sample sets for asbestos and MMVF in common areas sampled Indoor air sample sets for asbestos and MMVF in accessible areas of units sampled	Set = one sample for each appropriate COPC in each common space or unit sampled	Scaled as follows: small spaces (<160sf), a 3 sample set will be collected; spaces 160sf - 25,000sf, a 5 sample set will be collected; spaces >25,000sf, 1 sample set will be collected for each 5,000sf.

II. Analytical Parameters for Each Sample					
Sample	**Analytical Parameters**	**Sampling Method**	**Description**	**Analytical Method**	**Benchmarks**
Metal Wipe	Lead	HUD Appendix 13.1	Wipe samples	SW-846 6010C	Accessible loading 40 µg/ft^2 Infrequently accessed loading 400µg/ft^2 Window sill loading 250 µg/ft^2
PAHs Wipe	PAHs	ASTM D 6661-01	Wipe samples	SW-846 8270D	Accessible loading 150 µg/m^2 Infrequently accessed loading 1.5 mg/m^2
Microvac	Asbestos	ASTM D 5755-03	Microvac samples	ASTM D 5755-03	Accessible loading 5,000 structures/cm^2, Infrequently accessed 50,000 structures/cm^2
	MMVF	ASTM D 5755-03	Microvac samples	ASTM D 5755-03 Prep SEM analysis	Accessible loading 5,000 fibers/cm^2, Infrequently accessed 50,000 fibers/cm^2
Indoor Air Samples	Asbestos	NIOSH 7400 3600 liter sample	Air samples	40 CFR Part 763 (AHERA protocol)	0.0009 S/cc
	MMVF	NIOSH 7400 3600 liter sample	Air samples	PLM NIOSH 7400 “B” counting rules	0.01f/cc

APPENDIX 1 – FURTHER BACKGROUND INFORMATION

Extent of Contamination

EPA and many other agencies collected and analyzed environmental samples after the September 11, 2001 attack on the WTC. EPA has posted much of its monitoring data on its Web site at http://www.epa.gov/wtc/monitoring/index.html .

EPA has also made all of its data available to the public through the National Institute of Environmental Health Sciences and Columbia University at http://wtc.hs.columbia.edu/wtc/Default.aspx .

The EPA sampling data and the data from many other federal and state agencies are also available on a CD at http://oaspub.epa.gov/nyr/cd .

Remote monitoring data was collected and analyzed by the United States Geological Survey (USGS, 2001) the Aerospace Corporation (2002), and EPA's Environmental Photographic and Interpretation Center (US EPA, December 2005). The New York City Department of Environmental Protection (NYCDEP) conducted a building-by-building survey of the lower Manhattan buildings to determine the extent of external contamination (attached below is NYCDEP's Exterior Building Surveys Map, revised October 24, 2002). The plumes resulting from the collapse of the towers and subsequent fires were modeled by EPA (Gilliam, et al., 2005, Huber, et al., 2004).

It is clear from this data that the plumes from the collapse of the WTC and subsequent fires impacted much of the NYC metro area. The most heavily impacted area is approximately bounded on the north by Chambers Street and the Brooklyn Bridge approaches (Figure 2). This area is entirely contained within the area that was the subject of EPA Region 2's 2002-2003 Indoor Air Residential Assistance Program.

Impacts on the Indoor Environment

Shortly after the 9/11 attack, concerns were raised about the impact of the attack on the indoor environment. The Ground Zero Task Force commissioned a survey of two residential buildings (Chatfield & Kominsky, 2001). The buildings sampled were 45 Warren Street, four blocks north of Ground Zero (undamaged); and 250 South End Avenue, close to Ground Zero, to the southwest of the WTC (damaged). The Warren Street building was considered to have been exposed to lower concentrations of dust than that at South End Avenue. The purpose of the survey was to assess the levels of polychlorinated biphenyls (PCBs), dioxins, furans, metals, and asbestos inside the buildings. Sampling was conducted on September 18, 2001. The report concluded that concentrations of PCBs, dioxins, furans, and metals (excluding calcium) were generally low or below comparative background levels at both locations. Concentrations of asbestos found in dust samples and in the air inside the apartments were significantly elevated, and all of the indoor samples collected in the South End Avenue building exceeded ~0.05 S/cc PCMe.

From November 4 through December 11, 2001, the New York City Department of Health and Mental Hygiene (NYCDOHMH) and the Agency for Toxic Substances and Disease Registry (ATSDR) collected environmental samples in and around 30 residential buildings in lower Manhattan, and comparison samples in four buildings above 59th Street (NYCDOHMH/ATSDR, 2002). The samples collected were analyzed for asbestos, synthetic vitreous fibers, mineral components of concrete (crystalline silica, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite). Their 2002 report concluded that higher levels of asbestos, synthetic vitreous fibers (e.g., fiberglass), mineral components of concrete, and mineral components of building wallboard were found in settled surface dust in lower Manhattan residential areas when compared with comparison residential areas above 59th Street. NYCDOHMH and ATSDR recommended:

1) Frequent cleaning with HEPA vacuums and damp cloths/mops to reduce the potential for exposure;
2) Additional monitoring of residential areas in lower Manhattan;
3) An investigation to better define background levels specific to New York City for asbestos, synthetic vitreous fibers, mineral components of concrete, and mineral components of building wallboard; and
4) Residents in lower Manhattan who were concerned about potential WTC-related dust in their residences participate in EPA Region 2's Indoor Air Residential Assistance Program.

In February 2002, a multi-agency task force headed by EPA was formed to evaluate indoor environments for the presence of contaminants that might pose long-term health risks to residents. As part of this evaluation, a task force subcommittee was established (COPC Committee) to identify contaminants of potential concern that were likely to be associated with the WTC disaster and to establish health-based benchmarks for those contaminants during the planned (2002-2003) Assistance Program in lower Manhattan. A systematic risk-based approach was used to select COPC. The goal was to identify those contaminants likely to be present within indoor environments at levels of health concern. The following chemicals were identified as COPC: dioxins, polycyclic aromatic hydrocarbons (PAHs), lead, asbestos, fibrous glass, and crystalline silica.

Risk-based benchmarks were developed to be protective of long-term habitability of residential dwellings and were submitted for peer review (US EPA, 2003a).

EPA also conducted a cleaning study to evaluate the performance of the cleaning methods recommended in the NYCDOHMH and ATSDR report to ensure that the health-based benchmarks could be achieved by using them (US EPA, 2003c). EPA concluded the following:

1) Observation of apparently WTC dust at that time was a good indicator that WTC contaminants were present, and the amount of such dust correlated with the level of contamination;
2) Concentrations of some contaminants in the WTC dust were elevated above health-based benchmarks;

3) Use of a standard cleaning method of vacuuming and wet wiping significantly reduced levels of WTC-related contamination with each cleaning event and was successful in reducing concentrations to levels below health-based benchmarks (in some cases, 2 or 3 cleanings were necessary);
4) Asbestos in air is a good indicator of whether additional cleaning is needed; and
5) Standard HVAC cleaning methods reduced the concentrations of WTC contaminants in HVAC systems.

Concurrently, EPA also conducted a "Background Study" to determine levels of selected contaminants in fourteen residential buildings (north of 77th Street in Manhattan) not directly impacted by the airborne dust plume that emanated from the WTC site (US EPA, 2003b). EPA sampled 25 residential units and nine common areas within the 14 buildings. The contaminants studied included: asbestos, lead, dioxins, polycyclic aromatic hydrocarbons (PAHs), fibrous glass, crystalline silica, calcite, gypsum, and portlandite. The data collected from this study provided estimates of background concentrations for compounds that were identified as COPC related to the WTC collapse. The estimates were shown to be consistent with other background studies and historical data, where such comparison data were available.

Beginning in 2002, residents of lower Manhattan, who lived below Canal Street were provided a choice of services. Residents could choose to have their residence professionally cleaned, followed by confirmatory testing, or they could choose to just have their homes tested. Owners and managers of residential buildings and boards of cooperatives and condominiums could also have their building's common areas cleaned and tested and the HVAC system evaluated and cleaned, as necessary. The common areas cleaned and tested included areas such as the building lobby, hallways, stairways, and elevator interiors. Certain other common areas, including laundry rooms, utility rooms, compactor rooms and elevator shafts, were tested and cleaned as needed.

Between September 2002 and May 2003, residences were cleaned using standard asbestos cleanup methods: using HEPA-filtered vacuums and wet wiping all horizontal hard surfaces (i.e., floors, ceilings, ledges, trims, furnishings, appliances, equipment, etc.). Vertical and soft surfaces were HEPA vacuumed two times. Depending upon the size of the residence, from three to five air samples were collected and analyzed for asbestos by using transmission electron microscopy (TEM) and phase contrast microscopy (PCM). In a subset of the residences, pre and post-cleanup dust wipe samples were collected (e.g., from floors, walls, and furniture) and analyzed for dioxin, mercury, lead, and 21 other metals. A total of 4,167 apartments in 454 buildings and 793 common areas in 144 buildings were sampled for asbestos in air. A total of 28,702 valid sample results were analyzed; 22,497 from residential units, and 6,205 from common areas within residential buildings (e.g., hallways, laundry rooms).

The number of asbestos samples that exceeded the health-based benchmarks for airborne asbestos was very small, about 0.4% of the asbestos samples taken. In those residences and common spaces where the benchmark was exceeded in both residences and in common spaces, the cleanup program was successful in achieving the health-based benchmark for asbestos after the first cleaning approximately 99% of the time. An analysis of the location of asbestos exceedances does not demonstrate a spatial pattern of exceedances relative to WTC proximity. Apparent groups of asbestos exceedances could be explained by the location in the sampled buildings and the variability in the number of samples that were collected from each building. When we compared the frequency of detection from samples collected in the cleanup program with the frequency of detection for samples collected in the background study, we found that they were similar. There was a detection rate of 2% in lower Manhattan and 5% in upper Manhattan. The minimum concentrations from both areas were identical, while the maximum detected concentration in lower Manhattan was higher than the maximum detected concentration in upper Manhattan. Although the maximum detected concentrations were not similar between the two areas, the percentage of samples that exceeded the health-based criteria was similar, with 0.5% in lower Manhattan and 0.0% (no exceedances) in upper Manhattan. The mean values appear to be indistinguishable from background values.

Wipe samples were collected from 263 apartments in 156 buildings. Approximately 14% of the pre-cleanup samples exceeded the 25 $\mu g/ft^2$ U.S. Department of Housing and Urban Development screening level. There were very few exceedances of the health-based screening values measured for any of the other 22 metals. The 627 $\mu g/m^2$ screening value for antimony was exceeded in two pre-cleanup samples (0.1% of all samples); the maximum measured value was 1,180 $\mu g/m^2$. The 157 $\mu g/m^2$ screening value for mercury was exceeded in five pre-cleanup samples (0.4% of all samples). Only eight of the 1,535 (approximately 0.5%) of the combined samples (i.e., test only, and clean and test) exceeded the health-based benchmark for residential dust dioxin loading of 2 ng/m^2. The percentage of apartments that exceeded the lead health-based benchmark was greater than the percentages of apartments that had exceedances for other metals, mercury and dioxin. The frequency of detection, the maximum detected concentration, and the percentage of samples that exceeded the risk-based criteria were higher in the dust cleanup program in lower Manhattan when compared with the results from the background study in upper Manhattan. The clearest relationship found was between lead concentrations and age of building, suggesting lead paint as a cause for high lead measurements in lower Manhattan. Proximity to the WTC and floor of the building seemed to be, at best, weakly related to measured levels of lead. The level in lower Manhattan was consistent, however, with data from the HUD on mixed age housing stock in the northeast United States. This factor makes it difficult to distinguish between lead from WTC dust and other sources, especially in older buildings.

Further insight into these results may be gained by considering the post 9/11 cleaning history of the two buildings that were involved in the sampling by the Ground Zero Task Force. The 45 Warren Street building management did not request a whole building evaluation during EPA Region 2's 2002-2003 Indoor Air Residential Assistance Program. However, an individual resident requested an evaluation of his or her apartment. The apartment had been cleaned prior to the establishment of the dust cleanup program. It was re-cleaned and then tested. No asbestos fibers were found in the apartment.

In response to an NYC inquiry, the 250 South End Avenue management provided information to NYCDEP regarding post 9/11 cleanup work done at the building. The summary of this information indicated that six bulk samples were collected in the building, one of which tested positive for asbestos. The building exterior and interior were reported to have been cleaned by the condo association and unit owners. Thirty-five air samples were collected, and all were reported to be below the clearance level of 70 structures/mm^2 pursuant to the Asbestos Hazard Emergency Response Act (AHERA). During the EPA Region 2's 2002-2003 Indoor Air Residential Assistance Program described above, the HVAC system was inspected and 26 apartments and all of the common areas in 250 South End Avenue were either tested or cleaned by EPA. Visible WTC dust was noted in the HVAC air intakes only up to the filters and in exhaust discharges. These were cleaned by EPA. A total of 247 samples were collected in apartments and common areas. Asbestos was detected in only four of these samples, none of which exceeded the 0.0009 S/cc EPA clearance criteria.

Urban Background Contamination

Lead, asbestos, MMVF, and PAHs were the COPC to be included in a sampling program if a WTC signature had been validated. ATSDR has published Toxicological Profiles for each of these substances (ATSDR, 1999, 2001, 2004, 2005). Below are extracts from the relevant Toxicological Profiles describing the distribution and prevalence of these contaminants.

Lead: Atmospheric deposition is the largest source of lead found in soils. Lead is transferred continuously between air, water and soil by natural chemical and physical processes such as weathering, runoff, and precipitation, dry deposition of dust and stream/river flow; however, soil and sediments appear to be important sinks for lead. Lead particles are removed from the atmosphere primarily by wet and dry deposition. The average residence time in the atmosphere is ten days. Over this time, long-distance transport, up to thousands of kilometers, may take place. Lead is extremely persistent in both water and soil.

Asbestos: The general population is exposed to low levels of asbestos primarily by inhalation. Small quantities of asbestos fibers are ubiquitous in air. They may arise from natural sources (e.g., weathering of asbestos-containing minerals), from windblown soil from hazardous waste sites where asbestos is not properly stored, and from deterioration of automobile clutches and brakes or breakdown of asbestos-containing (mainly chrysotile) materials, such as insulation.

The concentration of fibers in indoor air is also highly variable, depending on the amount and condition of asbestos-containing materials in the building. Typical concentrations range from 1 to 200 ng/m^3 ($3x10^{-5}$ to $6x10^{-3}$ PCM f/mL).

MMVF: The general population can be exposed to low levels of synthetic vitreous fibers when insulating material or other synthetic vitreous fiber-containing material such as ceiling boards are physically disturbed and fibers become suspended in the air. Home, building and appliance insulation are often composed of glass wool, rock wool, or slag wool, and low levels of synthetic vitreous fibers have been detected in indoor air. These levels are usually on the order of about $1x10^{-4}$ fiber/cc, although higher levels are often observed during the installation of insulation in attics or ceilings; however, these levels quickly return to pre-installation levels, usually in one or two days. Low levels of synthetic vitreous fibers have also been detected in outdoor air, and available data suggest that there are little differences in the concentration of these fibers near source-dominated areas (e.g., near production plants) when compared to other locations. Typical levels of synthetic vitreous fibers in outdoor ambient air can vary, but are also on the order of about $1x10^{-4}$ fiber/cc.

PAHs: Particle-bound PAHs can be transported long distances and are removed from the atmosphere through precipitation and dry deposition. PAHs are transported from surface waters by volatilization and sorption to settling particles. The greatest sources of exposure to PAHs for most of the United States population are active or passive inhalation of the compounds in tobacco smoke, wood smoke and contaminated air, and ingestion of the compounds in foodstuffs. The general population may also be exposed to PAHs in drinking water and through skin contact with soot and tars. Higher than background levels of PAHs are found in foods that are grilled or smoked. Estimates of human exposures to PAHs vary. The average total daily intake of PAHs by a member of the general population has been estimated to be 0.207 µg from air, 0.027 µg from water, and 0.16 - l.6 µg from food. The total potential exposure to carcinogenic PAHs for adult males in the United States was estimated to be 3 µg/day. Smokers of unfiltered cigarettes may experience exposures twice as high as these estimates.

In some instances more recent information is available to supplement the ATSDR information on the distribution of the COPC.

Lead: HUD published the National Survey of Lead and Allergens in Housing in October 2002 (US HUD, 2002). They estimated that approximately 15% of all U.S. housing units have interior lead-contaminated dust which poses a hazard.

Researchers at the City University of New York (Hunter), Environmental Medicine, Inc., and New York University recently published work (Caravanos et al., 2005) indicating that 86% of exterior dust samples collected in New York City exceed the HUD screening level and that lead in dust on a surface adjacent to an open window accumulated at a weekly rate varying from 1.6 to 40.8 ug/f^2 with a median of 4.8 ug/f^2. Lower Manhattan had the lowest measured values of lead in exterior dust.

This finding was considered together with other recently published work describing re-suspension of lead from soil in Southern California (Harris and Davidson, 2005) and the large amounts of lead that were deposited in New York City from auto traffic and municipal waste incineration (Walsh, et al., 2001).

MMVF: Peer reviewers of the Final Report on WTC Dust Screening Study noted that background results and spiked sample results were statistically indistinguishable when the entire data set was considered (US EPA, 2005). EPA reanalysis of this data indicates that, with some qualification, the results demonstrate that labs that met the Measurement Quality Objectives (MQOs) for the project were able to distinguish among test samples. However, the overall variability observed in the inter-lab data and the demonstrated possibility of observing high levels of slag wool at sites not affected by the WTC collapse raise significant questions concerning the ability to use slag wool measurements generated with the current method as a tool for screening a sampled location for the presence of WTC related contamination (US EPA, 2006).

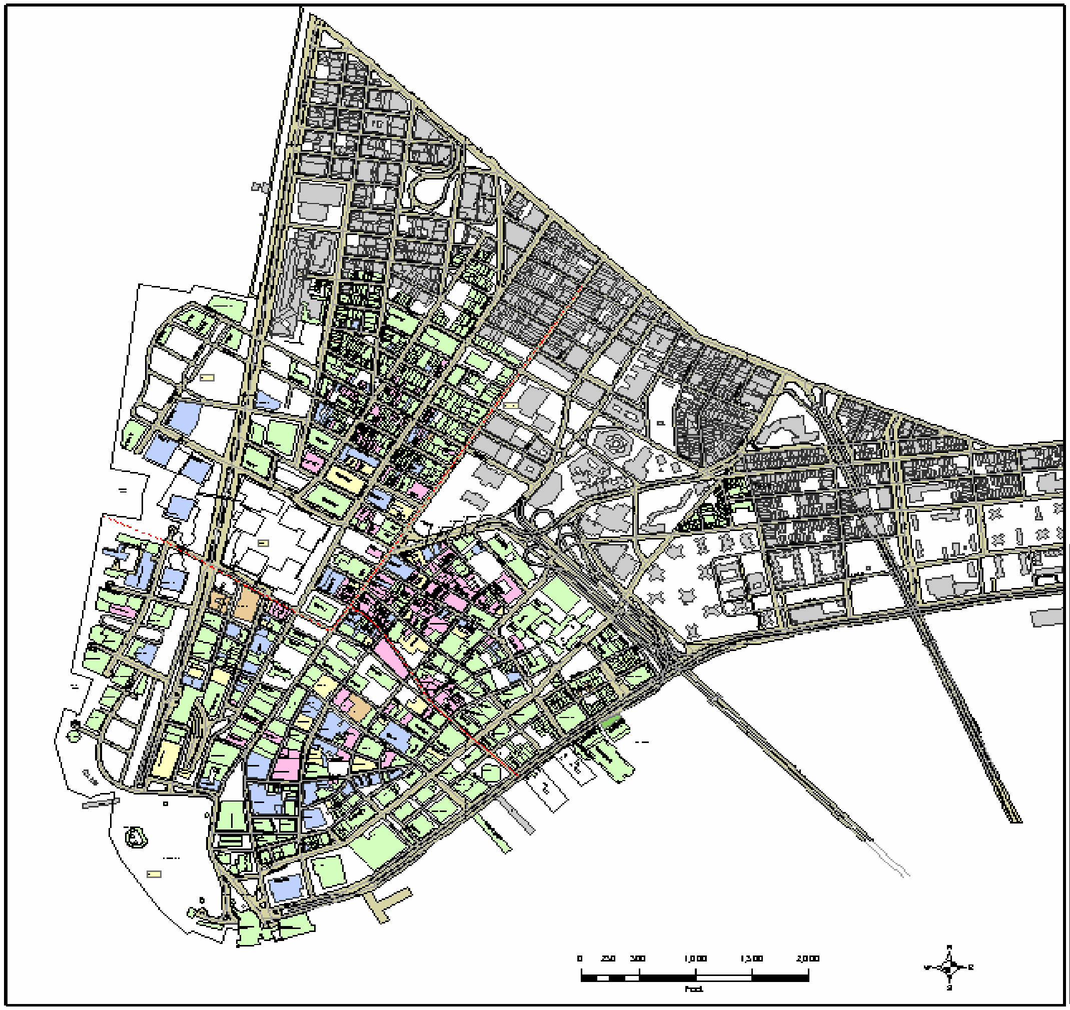
PAHs: Researchers from Rutgers and their collaborators measured annual average total atmospheric deposition fluxes for 36 PAHs to water surfaces in New Jersey ranging from 540 to 7300 ug/m^2/year. The order of highest to lowest fluxes follows the trend: Jersey City, Camden, Sandy Hook, Tuckerton, New Brunswick, Alloway Creek, Pinelands and Chester (Gigliotti et al., 2005). The lowest of these annual deposition rates is greater than our cleanup benchmark for PAHs.

EPA Interpretation of Existing Data

With the exception of heavily impacted buildings which remain uncleaned, such as the former Deutsche Bank building at 130 Liberty Street, the level of contamination measured in indoor environments in the area most heavily impacted by the plume is low. No pattern that could be related to the WTC collapse was detectable in this area of lower Manhattan. It appears that cleaning efforts by residents, building owners and operators, EPA, and NYC, where applied, have been successful in reducing levels of contamination. The COPC asbestos, MMVF, and lead, are common materials in the urban environment. Silicates form 59% of the earth’s crust. PAHs and dioxins are produced by many combustion sources, including automobiles and the 28,000 structural fires that occur in NYC each year. We estimate that there are over 170 million square feet of interior space in lower Manhattan. There may be areas within this space that have not been cleaned of WTC dust. The lack of a specific indicator for WTC dust, the nature of the contaminants, the widespread, low-level, background contamination from other urban sources, and the large and varied nature of the space involved make a sampling effort to identify additional areas whose cleanup would result in a reduction in exposure to WTC contaminants infeasible.

EPA has identified a small number of buildings that were not cleaned and are currently unoccupied. All of these buildings are scheduled for demolition or reconstruction. EPA and a number of federal, state, and local agencies are cooperating to ensure that this work is carried out in a manner that will not adversely impact public health and the environment.

EXTERIOR BUILDING SURVEYS



NYCDEP
EXTERIOR BUILDING SURVEYS

Revised 10/24/02

LEGEND

- BUILDING INSPECTED/NO VISIBLE DEBRIS
- BUILDING INSPECTED/VISIBLE DEBRIS
- NO ACCESS
- BUILDING NOT INSPECTED
- BUILDING CLEANED BY DEP
- BUILDING CLEANED BY OWNER
- BUILDING DESTROYED

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